Reducing Your Heating Bills

A Community Workshop

Presented by
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Sponsored by the Community Outreach Partnership Center and East Central Reinvestment Corporation

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Workshop overview

- Where this information comes from
- How air moves in houses
- Misaligned thermal and pressure barriers
- Key junctures
- Dense pack insulation

What's the conventional wisdom?

What are the things you have heard one should do to reduce heating bills?

Convention wisdom says...

- Caulk and weather-strip cracks
- Install replacement windows
- Insulate the attic
- Install heavy drapes on windows

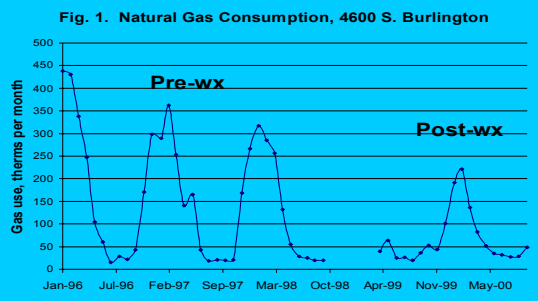
Our recommendations

- Seal the big air leaks at the top and bottom of the house
- Pay special attention to "key junctures"
- Insulate only after sealing air leaks
- Bring the ducts inside
- Seal crawl space vents

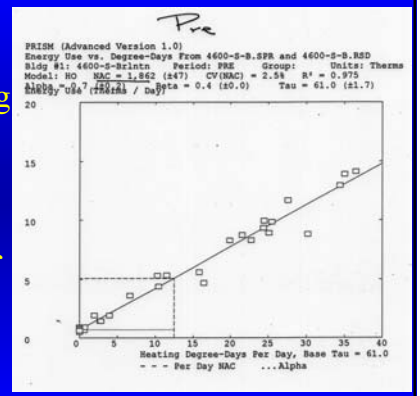
How we've come to this new understanding of how buildings work

1. Evaluation of actual energy savings in weatherization programs, which showed very small savings
2. New diagnostic tools such as blower doors and digital pressure gauges
3. Building Science out of Canadian research labs
4. Crews working in the DOE-funded Low-Income Weatherization Program

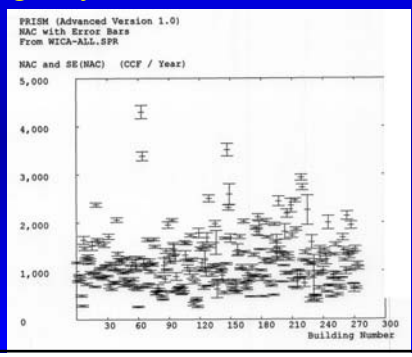
1. Evaluation of energy savings



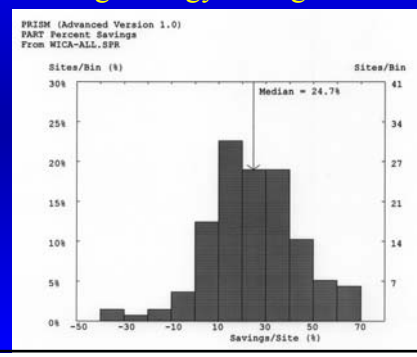
PRISM (Princeton Scorekeeping Method) software made analysis of savings easier



Example PRISM analysis of one agency's weatherized homes

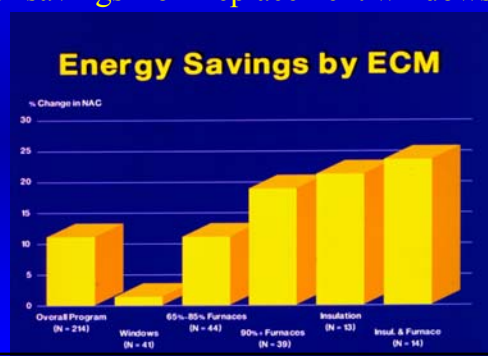


Good weatherization agencies typically achieve average energy savings of about 25%



This might help a little, but there are better ways to save energy

Savings from Indiana ECFAP. Note lack of savings from replacement windows



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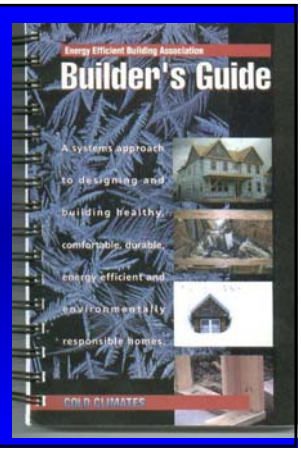
2. New diagnostic equipment: The blower door revolutionized the way we look at buildings

The digital manometer allowed us to measure tiny pressure differences

Miniature data loggers allow us to record temperatures over time

3. Joe Lstiburek brought Canadian Building Science to the U.S.

Joe's web site is BuildingScience Corp.com



4. Last but not least, we've learned a lot from the dedicated people working in the Low-Income Weatherization Program

High tech diagnostics -- See where the snow melts

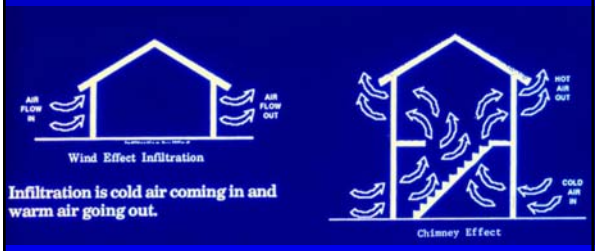
Frost works equally well for spotting heat leaks

Priority #1: Reduce air leakage (infiltration)

Building Science Fundamentals

- Source
- Hole
- Driving force

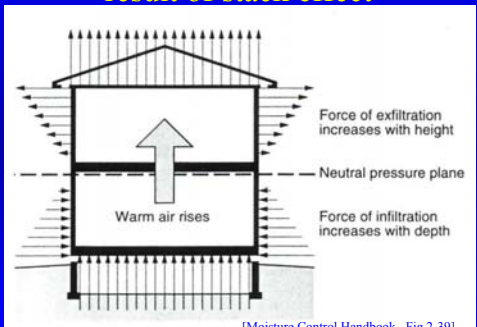
Principal driving forces for air movement in buildings



Stack effect -- a 24/7 driving force

- Warm buoyant air produces a pressure difference(driving force) 24 hours a day all winter long
- Creates the following pressure distribution between inside and outside of house:
  - Positive pressure at top of house
  - Negative pressure at bottom
  - Zero pressure difference halfway between top and bottom (the neutral pressure plane)

Pressure distributions in a house as a result of stack effect



[Moisture Control Handbook, Fig 2-39]

Figure 2-39: Air pressure patterns caused by the stack effect.

Stack effect fundamentals

- Pressure is directly proportional to height and temperature difference
- The greater the pressure, the greater the driving force
- The greater the driving force, the more infiltration and exfiltration

Stack effect demonstration box

- Can be used to model any building
- The "heating system" is a 250 W light bulb
- Set to model a single story home on a day when the temperature difference between inside and out is 40°F

e.g., $T_{inside} = 70^{o}$ F

$T_{outside} = 30^{o}$ F

Stack effect demo -- questions

- Most important air leakage sites?
- Most important doors in a house?
- Solution to cold floors, frozen pipes in crawl space or basement?
- Solution to radon in the basement?
- Why does the CO from the attached garage get drawn into the house?
- How do you get builders' attention?

One strongly held myth on house air tightness

"Houses should not be made too tight; you need to leave some cracks/holes for ventilation to insure good indoor air quality."

("The Ol' "House Needs to Breathe" Argument)

Can leaving a house "intentionally leaky" work to provide ventilation?

- When will the home be well ventilated? That is, when is the "stack effect vent fan" moving the most air?
- How well does this "stack effect vent fan" work during the rest of the year?

Where ***are*** the most important air leakage sites?

- Penetrations at top and bottom of house -- for wires, pipes and recessed lights
- Attic and crawl space access doors
- Top and bottom plates
- Rim joist/band joist area

Wire penetrations through the top plate are especially important

Pipe penetrations through subfloor also see large driving forces

Fiberglass is **not** an air barrier!

Fiberglass will only filter the air as it leaks into the attic

Recommended for air sealing: Enerfoam™ or equivalent foam

Real houses have many complex air leakage paths

Stack effect says we need to seal leaks at the bottom and top of the house

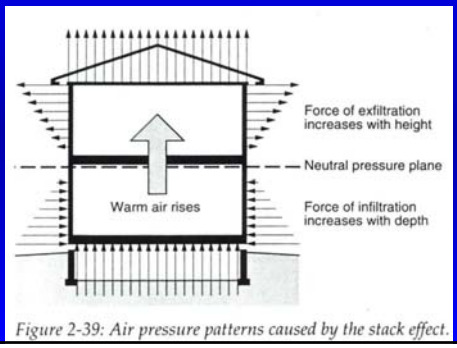
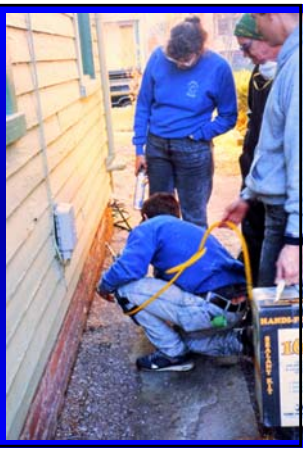


Figure 2-39: Air pressure patterns caused by the stack effect.

Need to air seal crawl spaces and basements….



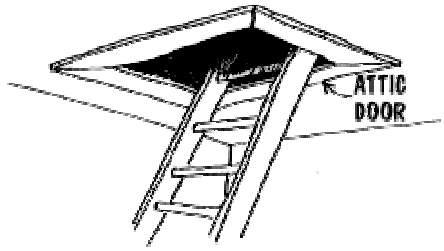
And you absolutely need to get into attics, no matter how difficult…

Most attics have large holes around pipe penetrations

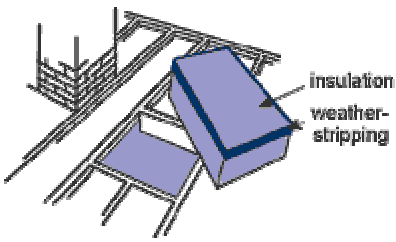
Big holes over interior walls

Dropped ceilings over closets are common in older homes

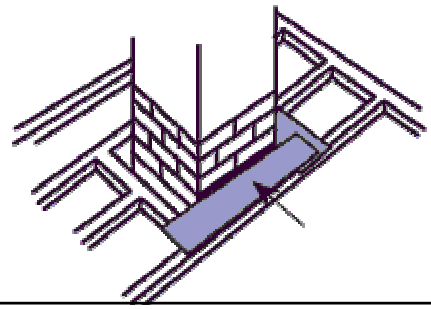
The most important "door" in the house for energy savings



The attic access needs to be airtight and insulated

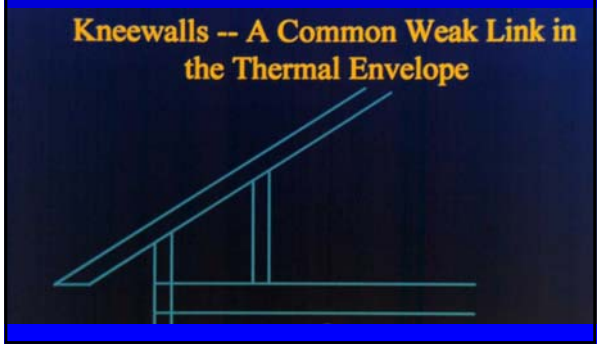


Large hole around chimneys should be sealed with fireproof materials such as sheet metal



A typical side attic

Kneewall & side attic -- a key juncture



Backside of kneewall in attic has been retrofitted with an "insulation pillow" which also covers and insulates a duct

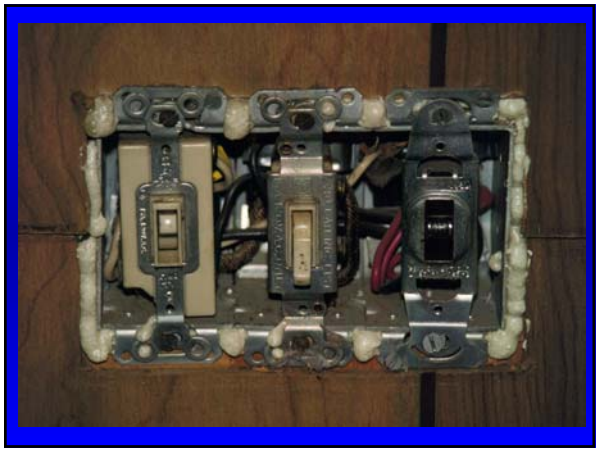
Crawl space vents -- large holes at the bottom of the house

One of the most important doors in the house to make airtight

The thermal barrier and the pressure barrier must be in the same place

- **Thermal barrier:** Where you put the insulation (It separates the warm side from the cold side)

  Pressure barrier: The air barrier (This needs to be continuous and as airtight as possible)



What the homeowner did:

- Put plastic over the windows
- Foamed electrical boxes and pipe penetrations under the sink
- Put R-19 insulation under the floor
- Put R-19 insulation on top of the ceiling

And the kitchen was still cold!

What's the dropped ceiling hiding?

Fiberglass insulation removed from above dropped ceiling (It's working just as well on the floor as it was on the ceiling.)

Many houses, including brand new ones, have holes this big which allows air to "bypass" the insulation

Professionals use a "blower door" to depressurize the house so that air leaks can be easily located

Do-It-Yourself Ways for Finding and Sealing Air Leaks Between Living Area and Attic

- Discolored (black) insulation indicates an air leak underneath
- Pull the insulation back and seal leaks with foam, cardboard and caulk, plastic bags filled with insulation, etc
- Note! Do not place flammable materials against recessed ceiling lights (unless IC rated), chimneys or flue pipes

An relatively easy to fix problem in homes built before about 1920

- The symptoms
  - High heating bills
  - Cold interior walls
- The cause
  - Balloon framing
  - Stack effect

Insulating old homes

- Attic insulation
- Sidewall insulation
- Air-sealing and insulating key junctures
  - Side attics
  - Porch connections
  - Balloon framed walls

Seal all air leaks before insulating!

Air-sealing competition at State Weatherization Conference

Typical poorly insulated attic

If you use fiberglass it is especially important to air seal first

Blown cellulose insulation is a good way to go

Blowing cellulose in an attic

"Dense packing" sidewalls with cellulose insulation.

This insulation method is also known as "tubing walls"

Properly installed (dense packed) cellulose insulation will not settle

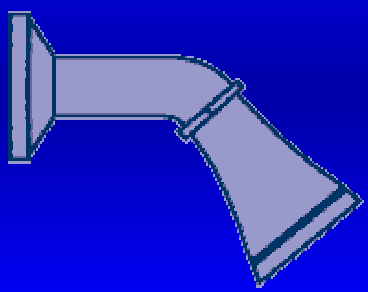
Cellulose blown into walls under pressure finds and seals all air leaks

Other low-cost energy savings measures for the home

Compact Fluorescent lights cost more initially, but save you money on electric bills

Insulate your water heater

Install low-flow showerheads



Workshop #2, Tuesday, December 3rd -- Carbon Monoxide

Faulty furnace blamed for carbon monoxide danger

When Karen's gas furnace kicked on last year, it spread more than warmth through her home. It leaked deadly carbon monoxide.

The problem was caused by a crack in the furnace's heat exchanger. Instead of escaping the house through the chimney, carbon monoxide leaked through the crack and into the home.

Before long, her family had flu-like symptoms: headaches; dizziness; nausea; and fatigue.

"After I read your bill message about carbon monoxide, I began to put two and two together," Karen said. That's when she called a furnace repairman to check her 15-year-old furnace. "He shut it down on the spot."

Safe at home -- Karen of Grand Rapids protects her family with an annual furnace checkup.

Workshop #3, Thursday, December 12th -- Avoiding mold and other moisture problems